

[PROC. ROY. SOC. VICTORIA, 47 (N.S.), PT. II., 1935.]

ART. XVI.—*Victorian Graptolites (New Series). Part III.*By WM. J. HARRIS, D.Sc.
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[Read 11th October, 1934; issued separately, 8th May, 1935.]

The graptolites described in the present paper are for the most part high Darriwilian forms from the area east of Bendigo, and include those on which the subdivision of the Darriwilian beds is based. Others are interesting for purposes of comparison or from an evolutionary point of view.

Biserial forms predominate in the D2 and higher zones which have been included by one of us(11) in a *Diplograptus* series. *Glyptograpti* are abundant, including mutations between *D. (Glyptog.) dentatus* (Brong.) and *D. (G.) teretiusculus* (His.). *D. (G.) intersitus*, sp. nov., is one of these, and is so restricted in range that it serves as a zonal fossil. *D. (G.) euglyphus* (Lapworth) is common in the higher beds. Dichograptid species are still common, but become progressively rarer in the higher beds. Many of the *Didymograpti* show thecal elaboration. The presence of these complex forms adds interest but also difficulty to the task of description, since the material available is for the most part soft, soapy shale in which details of graptolite structure are not clearly seen.

A notable feature is the general resemblance of the upper Darriwilian forms here described to those described and figured by Bulman(1, 2) from South America. Though it seems unsafe to insist on specific identity in many cases, it seems clear that further work will emphasize the equivalence of horizon of our beds to the South American beds referred to the Llanvirnian, in spite of the notable absence of the dependent *Didymograpti* from these Victorian beds.

At the end of the paper a list is given showing the position of graptolite localities referred to by numbers in the body of the paper. The stratigraphy of the area from which most of the Upper Darriwilian forms were obtained, with graptolite associations and remarks on zoning, is given in an accompanying paper by Harris(11).

The forms described and figured are:—

Family DICHOGRAPTIDAE Lapworth.

Genus PTEROGRAPTUS Holm.

Pterograptus incertus, sp. nov.

Genus TRICHOGRAPTUS Nicholson.

Trichograptus immotus, sp. nov.

Genus TETRAGRAPTUS Salter.

Tetragraptus defensus, sp. nov.

Genus DIDYMOGRAPTUS McCoy.

- Didymograptus cognatus, sp. nov.
 " distinctus, sp. nov.
 " cuspidatus Ruedemann
 " compressus, sp. nov.
 " nodosus Harris
 (?) Didymograptus dubitatus, sp. nov.

Family DIPLOGRAPTIDAE Lapworth.

Genus DIPLOGRAPTUS McCoy.

- Sub-genus GLYPTOGRAPTUS Lapworth.
 Glyptograptus austrodentatus Harris and Keble.
 " intersitus, sp. nov.
 " euglyphus (Lapworth).
 Sub-genus MESOGRAPTUS Elles and Wood.
 (= DIPLOGRAPTUS McCoy, sensu stricto.)
 (?) Mesograptus decoratus, sp. nov.
 Sub-genus AMPLEXOGRAPTUS Elles and Wood.
 Amplexograptus modicellus, sp. nov.
 " confertus (Lapworth).
 " differtus, sp. nov.

Genus CRYPTOGRAPTUS Lapworth.

- Cryptograptus schaferi (Lapworth).

Family GLOSSOGRAPTIDAE Lapworth, emend. Elles and Wood.

Genus GLOSSOGRAPTUS Emmons.

- Glossograptus acanthus Elles and Wood.
 (?) Glossograptus crudus, sp. nov.

Genus LASIOGRAPTUS Lapworth.

- Sub-genus HALLOGRAPTUS Carruthers.
 Hallograptus proteus, sp. nov.
 Sub-genus THYSANOGRAPTUS Elles and Wood (= Lasiograptus Lapw).
 Thysanograptus etheridgei Harris.

Family ISOGRAPTIDAE Harris.

Genus CARDIOGRAPTUS Harris and Keble.

- Cardiograptus crawfordi Harris.

Family DICHOGRAPTIDAE Lapworth.

Genus **Pterograptus** Holm.

PTEROGRAPTUS INCERTUS, sp. nov.

(Fig. 1, Nos. 1 and 1a; Fig. 2, Nos. 1-6.)

Description.—From a long and slender sicula two dependent stipes diverge at an angle usually of more than 90°, but sometimes less. These in turn, apparently by dichotomy, give rise to a number of stipes ranging from three or four to eight, forming a *Bryograptus*-like rhabdosome. Thecae of simple dichograptid type, 10-11 in 10 mm., 2-3 times as long as wide, with small overlap, concave ventral margins and straight or slightly concave apertures, the apertural margins approximately normal to the

axis of the stipe. The sicula is rather less than 1 mm. long, and the first theca originates sub-orally. The first dichotomy takes place sub-orally from th 1¹ and th 1², and further dichotomy from succeeding thecae. The distal stipes are in every observed case less than 1 mm. wide and often considerably less.

Remarks.—This form provides an example of the difficulty of classifying graptolites by method of branching. By that criterion the four-branched forms might be regarded as dependent *Tetragrapti* like *T. pendens*, and the forms with more numerous branches resemble externally *Bryograpti* of a much lower horizon, yet the affinities of the species are rather with *Pterograptus* than with these earlier genera. Dichotomy may possibly be due to the equal spacing of the thecae as regards food supply.

Affinities.—The present species can be easily distinguished from *P. scanicus* Moberg and *P. lyricus* Keble and Harris by the general form of the rhabdosome. It is a much more robust form than *P. elegans* Holm, from which it differs also in thecal characters. In general habit it differs from the unnamed form figured by Bulman from Bolivia(1), although a form resembling this occurs in the same beds but has not yet been found in a sufficiently well-preserved state for description.

Localities and Horizon.—Widely distributed and locally abundant at Upper Darriwilian localities in the Strathfieldsaye district, where it is most characteristic of a sub-zone between the zones of *Diplograptus* (*Glyptograptus*) *austrudentatus* and *D. (G.) intersitus*. For example, on the road near Allot. 3 of Sect. IX., Strathfieldsaye (Caldwell's loc. A. 169), it is associated with *D. (G.) austrudentatus* and *D. (G.) intersitus*, while further south (locs. 283–285) it is associated with *D. (G.) intersitus*. At other outcrops of *D. (G.) intersitus*, apparently higher, such as loc. 196, it occurs very rarely.

Genus *Trichograptus* Nicholson.

TRICHOGRAPTUS IMMOTUS, sp. nov.

(Fig. 1, Nos. 2a-c; Fig. 2, Nos. 7, 8.)

Description.—Rhabdosome slender, bilaterally symmetrical, consisting of two main branches which diverge at about 150° but soon turn back to form almost a straight line or even take up a reclined position. Each of these gives off, from successive thecae near their apertures, secondary branches on the same side of the main stipes. These secondary stipes do not divide further. Sicula long and narrow, the primary thecae also long, narrow tubes, about 8 in 10 mm. Thecae on secondary stipes about 10–11 in 10 mm. inclined at an angle usually less than 25°, slightly overlapping, with apertural margins almost straight and generally at right angles to the axis of stipe.

Remarks.—By its size and general aspect this form may be distinguished from *Trichograptus fergusoni* T. S. Hall and *T. fragilis* (Nicholson). It is probably more closely related to *T. crinitus* Moberg, but differs from this Swedish form in having more rigid primary and secondary stipes and in having the thecae on the primary stipes more loosely spaced—8 in 10 mm. as compared with 10—thus spacing the secondary stipes more widely. The general characters of the thecae on the secondary stipes agree fairly well, but the overlap in our species is, if anything, somewhat less than in Moberg's species.

Horizon and Locality.—Rather rare in the upper Darriwilian beds (zone of *Didymograptus nodosus*) of Allot. 8, Section XXIX., Huntly (Bendigo).

Genus *Tetragraptus* Salter.

TETRAGRAPTUS DEFENSUS, sp. nov.

(Fig. 2, No. 9.)

Description.—Rhabdosome consisting of four reflexed stipes widening gradually from less than 1 mm. to nearly 2 mm. Thecae 16–10 in 10 mm. The characteristic feature is the presence on distal portions of the stipes of stout dorsal spines 1 mm. long, at right angles to the axis of the stipe and numbering 7 in 10 mm.

Remarks.—This description is based on one poorly-preserved specimen, but this is so distinct from any form yet found in Australia that special attention is called to it. In the nature and disposition of its dorsal spines this species resembles *T. echinatus* Clark (3, p. 65), but it seems to differ from Clark's species in every other respect—form, thecal measurements, etc. The state of preservation unfortunately does not permit of greater descriptive detail, and should better material be found later, the specific description may require amendment. From the description and figure future workers should be able to recognize any fragments that may come to light.

Horizon and Locality.—The single specimen was obtained from a band of pink and bluish-purple shale outcropping on the east and west road between Sects. 25 and 26, Strathfieldsaye, on the continuation of the band marked on Caldwell's plan of Strathfieldsaye as A.169. The horizon—high D2 (zone of *Diplograptus* (*Glyptograptus*) *austrudentatus*)—closely approximates to that recorded by Clark for *T. echinatus* (3, p. 56).

Genus *Didymograptus* McCoy.

DIDYMOGRAPTUS COGNATUS, sp. nov.

(Fig. 1, Nos. 4a-c; Fig. 2, Nos. 13, 14.)

Description.—Stipes occasionally up to 3 cm. long (longer if the reference of fragmentary stipes to this species is correct), but usually much shorter, very narrow throughout, not exceeding

in our specimens a width of about 0.4 mm., diverging from a comparatively long and narrow sicula at an angle of 140° . Thecae 8 in 10 mm., triangular or slightly concavo-convex tubes with so little overlap as to appear to be placed almost end to end. Inclination very low, apertural margins straight or slightly concave, almost normal to axis of stipe.

Remarks.—The description of this slender *Didymograptus* approaches very closely that of *Didymograptus affinis* Nicholson. In spite of this, the cumulative effect of small differences is to give an impression quite distinct from that given by Elles and Wood's figures (4, pl. ii., figs. 1a, b). On close examination it will be seen that the overlap is even less than in the British species, the apertural margins are less concave, the ventral margins straighter, and there is no denticle. The species seems to have had a thin periderm, and consequently will be hard to find at outcrops where graptolites are not especially well preserved.

Horizon and Localities.—Common, but, on account of its delicacy, rarely well preserved in the upper Darriwilian beds of Bendigo East in the zone of *Didymograptus nodosus*, especially on the water-race in the south-east corner of Allot. 19, Sect. III., Strathfieldsaye (A.164).

Didymograptus distinctus, sp. nov.

(Fig. 1, No. 3; Fig. 2, No. 10.)

Description.—Sicula relatively long and slender, 1.5 mm. in length, but tenuous and often unobservable, its position being indicated only by the divergence of the horizontal stipes and the unequal length of $th\ 1^1$ and $th\ 1^2$. Rhabdosome small, stipes as observed not more than 2 cm. long, originating nearer the apex than the aperture of the sicula and diverging at an angle of 180° . Thecae triangular tubes with negligible overlap, 9-10 in 10 mm., inclined at an angle of 40° or more, ventral margins slightly concave, apertural margins almost straight and making an angle of 100° with the distal portion of the stipe.

Remarks.—The type specimen shows clearly the divergence of $th\ 1^1$, the budding of $th\ 1^2$ and its horizontal growth. We are unable to cite any very close relations of this form. *Didymograptus acutidens* Lapw. MS. and *D. cuspidatus* Rued. approach it in some respects. From the former it is readily distinguished by its shorter, broader thecae, their greater angle of inclination and smaller overlap. From *D. cuspidatus* it differs in the initially greater angle of divergence (absence of a central v), uniform width of stipes, uniform angle of inclination, and widely-spaced thecae.

Horizon and Localities.—The type is from the Specimen Hill and Fryerstown water-race south of the Elphinstone-Chewton railway (C1—upper Castlemainian). It also occurs on the same

horizon south of Bagshot railway station (Bendigo). Near the old agricultural show-grounds at Gisborne and in the Lancefield district ($\frac{LL}{20}$) it is found in Darriwilian beds.

DIDYMOGRAPTUS CUSPIDATUS Ruedemann.

(Fig. 1, No. 9; Fig. 2, Nos. 11, 12.)

1904. *Didymograptus cuspidatus* Ruedemann, Graps. N.Y., Part I. N.Y. State Museum Mem. 7, p. 684, figs. 79, 80, pl. 13, fig. 16.

Description.—Stipes originating sub-orally at slightly different levels from a comparatively small sicula at an angle of 150–160°, but later becoming sub-horizontal. Stipes 2 cm. or more long, narrow at first but rapidly widening to rather less than 1 mm. Thecae 12–13 in 10 mm., mature thecae with an overlap of one-third. Inclination of earlier thecae low, increasing to 40° or more in the distal portion of the stipes. Apertural margins slightly convex in most cases and approximately normal to the axis of the stipes.

Remarks.—The above description, drawn up from specimens from the upper Darriwilian of Strathfieldsaye, agrees well with Ruedemann's description and figures, which are based on a single specimen.

Horizon and Localities.—Rare in the high Darriwilian beds of Allot. 19, Sect. III., Strathfieldsaye (A.164), and at other Bendigo East localities in the zone of *Didymograptus nodosus*.

DIDYMOGRAPTUS COMPRESSUS, sp. nov.

(Fig. 1, Nos. 6a–c; Fig. 2, Nos. 20, 21.)

Description.—Stipes up to 8 cm. in length, and from the evidence of detached stipes, probably longer; uniformly slender, diverging from a comparatively long and slender sicula at an angle of about 120° (though sometimes at a greater or less angle), very narrow proximally but widening gradually till a width of 0.6 mm. is reached, this width being then maintained. The stipes swing back to a sub-horizontal position. Thecae 8–10 in 10 mm. long, sub-rectangular tubes, 4–5 times as long as wide, in contact for one-third to one-half their length, and inclined at an angle as low even as 10°. Ventral margins slightly sigmoid, apertural margins inclined at an angle of a little less than 90°.

Remarks.—The thecae of this species are characteristic, and it is comparatively easy to recognize from a fragmentary stipe. The thecal tubes seem to be sub-rectangular and wider than deep. Where in a species such as *D. extensus* a profile view would be expected, in this species one seems to look down on the ventral side of the thecae in perspective, and this side is often lighter in shade than the rest of the rhabdosome. Proximal thecae often have an indented apertural margin as if the periderm were thin and had been frayed from between the marginal lists.

Occasionally specimens are found in the *Didymograptus nodosus* zone with spines like those of some specimens of *D. nodosus*.

Horizon and Localities.—Common at many upper Darriwilian outcrops in the Bendigo East area and characteristic of the *D. (Glyptog.) intersitus* zone between the D2 zone (zone of *D. (G.) austrodentatus*) and the zone of *D. nodosus*. It is also found, though more rarely, with *D. (G.) austrodentatus*, as at loc. 169, and with *D. nodosus*. It is commonest, perhaps, at loc. 196 in the State Forest, Sect. XIX., Strathfieldsaye, along the McIvor Road near the 97m. 36 ch. railway crossing, and in Sect. XXIX., Huntly. It is worth noting that Bulman's figures (2, pl. xxxiii., fig. 6) of *Didymograptus* aff. *euodus* show considerable resemblance to *Didymograptus compressus*, especially the two fragmentary stipes in fig. 6b. The horizon of these forms is very close to that from which *Didymograptus compressus* is recorded in Victoria.

(?) *DIDYMOGRAPTUS DUBITATUS*, sp. nov.

(Fig. 1, Nos. 5a-d; Fig. 2, Nos. 22-25.)

Description.—This deflexed form has stipes up to 25 mm. in length, and probably longer, diverging from a comparatively long conical sicula (1 mm. long) at an angle of about 135° and then gradually flattening out. The stipes are very slender, not exceeding 0.5 mm. in width. Thecae 10 in 10 mm., five times as long as broad, overlapping less than one-half, inclined at a very low angle as they arise and then lying almost parallel to the axis of the stipe. The proximal thecae have not been clearly seen, partly owing to the way they are impressed on the stipe, but appear to be rather more typically didymograptid than the distal ones. In the distal thecae, as stated above, the apertural half seems to lie parallel to the axis of the stipe, due to the sigmoidal curve of the early portion of each theca. In the obverse aspect the thecae appear to open into a small but distinct excavation; in the reverse aspect the thecal apertures are somewhat extroverted, with a slight but characteristic constriction. These differing aspects point to torsion of the thecal axis.

Remarks.—The thecae of this species are peculiar, approaching those of *Atopograptus woodwardi*. The stipes are so narrow that it is difficult to note the characters of proximal thecae, and small forms with indistinguishable thecal characters are included in the species. The stipes widen gradually for about 1 cm. and then are practically parallel-sided. Comparison with other species is difficult. There is some resemblance to *Didymograptus compressus*, sp. nov., but this latter form is more robust and its thecae very different. *Atopograptus woodwardi* Harris is the only form for which fragments of *D. dubitatus* may be mistaken, the thecal characters in one form of preservation having a great resemblance. *D. dubitatus*, however, is much narrower than the

type specimen of *Atopograptus woodwardi* and its sicula is distinctly of the didymograptid type. This form is, therefore, left for the present as an aberrant *Didymograptus* showing thecal elaboration, as the development of *Atopograptus* is not well known, the only specimen of that genus showing proximal characters at all clearly being the type specimen, although fragments are common.

Horizon and Localities.—This species has been clearly seen only at one upper Darriwilian locality (loc. 164), at Strathfieldsaye (Bendigo East). It probably occurs in a similar association at other outcrops on the same horizon—zone of *Didymograptus nodosus*—but is difficult to recognize except from well-preserved material. The smaller forms provisionally included in the species are rather common in the Strathfieldsaye high Darriwilian beds.

DIDYMOGRAPTUS NODOSUS Harris.

(Fig. 2, No. 27.)

1926. *Didymograptus nodosus*. W. J. Harris, *Proc. Roy. Soc. Vic. (n.s.)*, xxxviii., p. 56, pl. i., figs. 1-4.

Two specimens of this species are figured showing a pronounced development of flexuous spines absent from the type material. This increases the resemblance of the species to *Didymograptus spinosus* Rued. (17, p. 689). If Ruedemann's specimens were less well-preserved it might be suggested that the two forms were identical, but the detail of *D. spinosus* as shown by Ruedemann in figs. 84, 85, shows a form quite distinct from *D. nodosus*. The spines are single and arise from the apertures of the thecae and also from the "heel," which is so pronounced a feature of the thecae of this species. As might be expected, the spines are best shown on distal thecae.

Horizon and Localities.—*Didymograptus nodosus* is a zonal graptolite of the highest Darriwilian beds, being associated with *Amplexograptus confertus* (Lapw.), (?) *Mesograptus decoratus*, etc. The spinose form has been collected at Strathfieldsaye (A.164) and at Huntly (Sect. XXIX).

Genus **Diplograptus** McCoy.

Sub-genus **Glyptograptus** Lapworth.

DIPLOGRAPTUS (GLYPTOGRAPTUS) AUSTRODENTATUS Harris and Keble.

(Fig. 3, Nos. 1-5.)

1932. W. J. Harris and R. A. Keble, *Proc. Roy. Soc. Vic. (n.s.)*, xlv. (1), text figs. 1-4; pl. v., figs. 4-5.

This species is re-figured for comparison with *Diplograptus (Glyptograptus) intersitus*, sp. nov., which is a typical graptolite of the next higher zone of the Darriwilian. The rhabdosome is squat and short (up to 15 mm. long) and about 2 mm. wide, with parallel sides. Proximally there is a stout virgella, which is not

always visible, but may be 2 mm. long. The first thecae are short, and the upward growth of th 1^1 and th 1^2 is not well marked. The proximal thecae have apertural spines. The thecae have well-marked ventral curvature and the apertures are slightly introverted. The virgula is produced for only a short distance beyond the distal end of the rhabdosome.

Horizon and Localities.—This graptolite is the zone fossil and commonest form in the D2 zone of the Darriwilian which has been placed as the basal bed of a *Diplograptus* series (11). Characteristic squat forms are figured, including some which are found as moulds in Allot. 2, Sect. XI., Sedgwick (A.310). The form is extremely common at many localities in the southern portion of the Bendigo East area, as well as in the Brisbane Ranges and at the other localities given by Harris and Keble (12, p. 41).

DIPLOGRAPTUS (GLYPTOGRAPTUS) INTERSITUS, sp. nov.

(Fig. 1, nos. 11a-e; Fig. 3, nos. 7-10.)

Description.—Rhabdosome comparatively small, averaging about 15 mm., but occasionally reaching 25 mm. in length, with a breadth not exceeding 2 mm. attained within the first 6 mm., usually with a short but conspicuous virgula distally and a short virgella proximally. Thecae 13-10 in 10 mm. The proximal end is quadrate, just over 1 mm. wide, and the first thecae have thin apertural spines which are not often preserved. The virgella is about 1 mm. long.

The sicula is just over 1 mm. long (about 1.2 mm.), and approximately three times as long as broad. Theca 1^1 arises about one-third of the distance from the apical end and grows downward before growing outward. Its aperture is distinctly everted. Theca 1^2 also grows distinctly downward, and its upward growth is stronger than that of th 1^1 . Thereafter budding is normal. Septum is complete.

Thecae 1^1 and 1^2 have fine apertural spines, but these are not always preserved. Ventral margins show slight sigmoidal curvature, and apertural margins are either horizontal or slightly introverted. The low angle of inclination is very characteristic—generally about 20° . Thecal overlap is about one-half, and the thecae are 4-5 times as long as broad. Distally the virgula is usually prolonged for a short distance, but in some cases it may be over 5 mm. long.

Remarks.—*D. (Glyptograptus) intersitus* is distinguished from *D. (G.) austrodentatus* by:—

- (i) its less sigmoidally curved thecae, with less introverted apertures;
- (ii) the narrowness and low angle of inclination of the thecae;
- (iii) its more tapering and less squat rhabdosome;
- (iv) its more pronounced virgula.

Its smaller size and narrower and more inclined thecae distinguish it easily from *D. (G.) teretiusculus*, to which it is closely allied, and it may be regarded as a forerunner of that species. Bulman(1) has described mutations between *D. dentatus* and *G. teretiusculus*, and the present form is similar in character. Its common occurrence, restricted range, and constant characters are factors which were considered in describing it as a distinct species.

Horizon and Localities.—*Diplograptus (Glyptograptus) intersitus* does not seem to occur with *D. (G.) austrodentatus*, the typical *Diplograptus* of the D2 zone, until the higher beds of that zone are reached as at loc. A.169, Strathfieldsaye. It then becomes exceedingly abundant as the typical graptolite of the next higher zone as at locs. 196, 210, 298, etc. It then becomes less common, but is occasionally found in the higher beds with *Diplograptus* (? *Mesograptus*) *decoratus* and *Didymograptus nodosus*. Its commonest associates in its particular zone are *Didymograptus compressus*, sp. nov., *Lasiograptus etheridgei* Harris, *Trigonograptus* cf. *ensiformis* Hall, *Glossograptus acanthus* E. and W., *Cardiograptus crawfordi* Harris, *Tetragraptus* spp., and *Phyllograptus* cf. *anna* Hall.

DIPLOGRAPTUS (GLYPTOGRAPTUS) cf. EUGLYPHUS (Lapworth).

(Fig. 3, nos. 39-41.)

1880. *Diplograptus (Glyptograptus) euglyphus* Lapworth, *Ann. Mag. Nat. Hist.* (5), v., p. 166, pl. 4, figs. 14A-E.
 1907. *Diplograptus (Glyptograptus) teretiusculus*, var. *euglyphus* Lapw. Elles and Wood, *Mon. Brit. Graps.*, Part VI., p. 252, text-fig. 172, pl. xxxi, figs. 2A-D.
 198. *Diplograptus (Glyptograptus) euglyphus* Lapw. Ruedemann, *Graps.* New York, Part 2, *N.Y. State Mus. Mem.* 11, pp. 369-370, pl. 25, figs. 21-23, text-figs. 315, 316

Description.—Rhabdosome typically long and narrow, up to 4.5 cm. in length, with a maximum breadth of 2.5 mm., widening gradually from a narrow sicular end (0.75 mm.) until the maximum width is reached in about 2 cm. There is a blunt virgella 1 mm. long. Lateral spines have not been observed. Thecae of the *Glyptograptus* type, proximally 13 in 10 mm., but distally only 9 or 10 in the same length, with overlap of about one-third to one-half.

Remarks.—In its general form and tapering rhabdosome our species approaches *D. teretiusculus* var. *euglyphus*, as figured by Elles and Wood (*vide supra*). The thecal measurements, however, are closer to those of *D. (Glyptograptus) teretiusculus* than to the variety or to *D. euglyphus* as described by Ruedemann(18). The proximal development is the same. It appears to be one of the many mutations between *D. (G.) dentatus* and *D. (G.) teretiusculus*, but is perhaps best recorded as *D. cf. euglyphus*.

Horizon and Localities.—Rare in the Upper Darriwilian as at Turner's Quarry (Bittern) and on the Howqua River. More common with *D. (Glyptograptus) teretiusculus* in the lowest beds of the Upper Ordovician, as at Ba67 (junction of Jackson's and Riddell Creek, Gisborne). The Upper Ordovician form seems to have rather more closely packed proximal thecae. These Victorian horizons can be correlated with the zones of *Didymograptus murchisoni* and of *Diplograptus teretiusculus* in the English succession, indicating that here *D. euglyphus* enters on a somewhat lower horizon than in England.

Sub-genus **Mesograptus** Elles and Wood.

(=**Diplograptus** McCoy, s.s.)

(?) **MESOGRAPTUS DECORATUS**, sp. nov.

(Fig. 3, nos. 31-38.)

1874. *Diplograptus pristis* His. R. Etheridge, *Ann. Mag. Nat. Hist.*, pl. 3, fig. 18.

1875. *Diplograptus palmicus* (Barr.). McCoy, *Prod. Pal. Vict.*, Dec. 2, p. 32, pl. xx., fig. 6.

Description.—Rhabdosome large, 3-6 cm. long, widening from a blunt proximal end (about 1.0 to 1.5 mm. wide) and reaching a maximum width of up to 4 mm., after which this width may be maintained or the rhabdosome may narrow slightly and gradually. The distal narrowing is very common. Virgella conspicuous and partly enclosed in a membrane. The virgella is usually well shown, and is often produced beyond the distal end of the rhabdosome to carry a heart-shaped vesicle. Thecae 12-7 in 10 mm., overlapping about one-half.

Remarks.—The type specimen is preserved as a pseudomorph in limonite, and shows features not observable in the more usual compressed specimens. The difference in appearance between the thecae on either side of the rhabdosome is due to the peculiar cross-section of the form which is shown in Fig. 3, No. 35B. This makes it impossible, strictly speaking, to refer the species to any of the described sub-genera of *Diplograpti*, but till further material in relief is available the erection of a new sub-genus would, in our opinion, be premature, since the sub-generic characters are not observable in ordinary specimens. Even in these, however, the difference between the appearance presented by the thecae on opposite sides of the rhabdosome is so constant that it cannot be regarded as due to deformation, but must be due to the shape of the cross-section.

On account of the limitation of the climacograptid appearance of the thecae to the proximal portion only, the form is tentatively referred to *Mesograptus*.

The apertural edges of the thecae are undulate (highest in the centre) and flanged, and the free ventral surface is also undulate with a medial longitudinal depression. The cross-section of the

rhabdosome is such that no undistorted specimens show what is normally the bi-profile view of *Diplograptus* (cf. figs. of *D. euglyphus*). This difference will be noticed in Fig. 3, Nos. 35, 36, 38. On one side the thecae appear as almost horizontal indentations, while on the other they are hardly observable, but the low angle of inclination of the thecal walls is very pronounced. The aperture on this side is not observable, being directed obliquely behind the surface shown.

In America and Great Britain trouble has been experienced in separating *Amplexograptus coelatus* from *Climacograptus antiquus* (4, 17), and the difficulty we are faced with is not decreased by the resemblance the present form bears to both these species and by its possession of a vesicle identical with that recorded by Ruedemann (17, p. 449) as possessed by *C. antiquus*. Each of Ruedemann's figures—with the vesicle at the end of a long virgula, or resting on the distal end of the rhabdosome—may be paralleled by Victorian specimens. On the other hand, the cross-section of the Victorian form is in itself sufficient to prevent its inclusion in the genus *Climacograptus*.

In measurements and general appearance compressed specimens of *D. decoratus* closely approach *D. (Amplexog.) coelatus* (Lapw.) which occurs on an equivalent horizon, and most Victorian records of *Diplograptus coelatus* are probably based on specimens of *D. decoratus*. It may be separated from *D. coelatus* by its *Amplexograptus* aspect in the proximal portion only, thus indicating a different cross-section in the mature portion. From British specimens of *D. coelatus* it is also distinguished by its distal vesicle. American forms with such a vesicle have, as stated, been referred to *C. antiquus*. The emphasis placed on the climacograptid character of *D. coelatus* is sufficient reason in itself for our description of *D. decoratus* as a distinct species having marked resemblances to *D. coelatus*. Lapworth (20) later emphasized the close relationship of *D. coelatus* and *D. (Glyptograptus) teretiusculus*. *D. decoratus* is a form which varies greatly, as may be seen from the figures, but every gradation between these forms may be found. Etheridge's and McCoy's descriptions of the present form were written when knowledge of the *Diplograpti* was limited, and it is unnecessary now to comment on their figures and descriptions (5, 15).

Horizon and Localities.—Common in the upper Darriwilian of Bendigo East, Cobaw (Geol. Surv. loc. B29, Q.S. 5 S.W.); Surprise Gully (Romsey); and north-west of Turner's main quarry, Allot. 27B, Bittern (Mornington Peninsula). It is characteristic of the zone above that of *Diplograptus (Glyptograptus) intersitus*, and is commonly associated with *Didymograptus nodosus*. However, it first appears with *D. intersitus* (it has not been recorded in association with *D.*

austrodentatus), and is also found in beds in which *Didymograptus nodosus*, if present, is rare. It has therefore a greater range than that form, and the *D. nodosus* association probably indicates the higher beds of its horizon.

AMPLEXOGRAPTUS MODICELLUS, sp. nov.

(Fig. 1, nos. 10a-f; Fig. 3, nos. 17-20.)

Description.—Rhabdosome small and parallel-sided—only a little over 5 mm. in length and 1 mm. wide. Sicular end unsymmetrically blunt, provided with a thin but conspicuous virgella, which may be more than 1 mm. long. Sicular narrow, 1 mm. long, the first theca budding some distance from its aperture and growing downwards along the sicular before turning outwards. Thecae closely spaced, 14–18 in 10 mm. (7–8 in 5 mm.), alternate, the free ventral edges slightly convex; excavations long, narrow and oblique, about one-fourth to one-third of the free ventral edge and one-third the width of the rhabdosome.

Remarks.—This small form (*modicellus*, very little) is similar in appearance to *Climacograptus pungens* Rued., but may be separated by the absence of the two proximal spines and the much more closely spaced thecae. It reminds one of *C. cf. modestus* as figured by Bulman (1, p. 51, fig. 22), but differs in the character of the proximal end and, what is more important, in the presence of a straight instead of a zig-zag septum. From *Amplexograptus arctus* E. and W., it may be separated by its small size and by the absence of lateral spines. Its nearest ally appears to be *Amplexograptus confertus* (Lapworth), but here again its smaller size makes it quite distinct.

Horizon and Localities.—Very abundant in certain bands of the Upper Darriwilian (zone of *Didymograptus nodosus*), associated with the characteristic assemblage of that zone. Some slabs, especially as loc. A164, Strathfieldsaye, are crowded with individuals showing all stages of growth.

AMPLEXOGRAPTUS CONFERTUS (Lapworth).

(Fig. 1, nos. 14a, b; Fig. 3, nos. 21-26.)

1875. *Climacograptus confertus*. Lapworth, *Quart. Journ. Geol. Soc.*, xxxi., p. 655, pl. xxxiv, figs. 4A-F.
 1880. *Climacograptus confertus*. Lapworth, *Ann. Mag. Nat. Hist.* (5), v., p. 169, pl. iv., figs. 15A-C.
 1907. *Diplograptus (Amplexograptus) confertus*. Elles and Wood, *Mon. Brit. Graps. (Pal. Soc.)*, lxi, p. 269, text-figs. 185A-C, pl. xxxi., figs. 18A-C.

Description.—Length usually 1.5 to 2 cm., though a length of 3 cm. may occasionally be reached. Width under 2 mm. (usually about 1.8 mm.). Rhabdosome almost parallel-sided, about 1 mm. wide or rather more near the proximal end.

Virgella about 1 mm. long, and a virgula prolonged for about the same length distally. Proximal end sub-quadrate, spines on thecae 1¹ and 1² sometimes preserved. Thecae 14-10 in 10 mm., in reverse aspect with well-marked oblique excavations occupying one-third to one-fourth of the ventral margin and one-third the width of the rhabdosome, in obverse aspect; ventral margin rounded, apertural margin thickened, concave, and oblique.

Remarks.—This description is so like that given by Elles and Wood (the only points of difference being the somewhat looser spacing of the thecae and the gradual widening) that we hesitate to make it a distinct variety. It appears to be nearer the typical *D. (Amplexog.) confertus* than the *A. cf. confertus* figured by Bulman (1, p. 60; pl. v., figs. 7-9). In thecal measurements it approaches *Amplexograptus differtus*, sp. nov., but the rhabdosome is narrower and has not the decided widening of that form. From *A. arctus* it may be distinguished by its greater width and its more typical amplexograptid thecae.

Horizon and Localities.—Common in the *Didymograptus nodosus* zone of the upper Darriwilian at localities in Sect. XXIX, Huntly (Bendigo); less common at other outcrops of the same horizon at Bendigo East.

AMPLEXOGRAPTUS DIFFERTUS, sp. nov.

(Fig. 1, no. 15; Fig. 3, nos. 27-31.)

Description.—Rhabdosome up to 2.5 mm. long, widening gradually from a blunt proximal end and reaching its maximum width of 2.0 to 2.5 mm. in about 1 cm., this width then being maintained. Thecae 13-10 in 10 mm.; apertures slightly inclined with notably thickened margins, the apertures occupying one-third of the width of the rhabdosome and one-fourth to one-third of the free edge. Virgula occasionally prolonged beyond the distal end of the rhabdosome.

Remarks.—In shape and general appearance this species is reminiscent of *Amplexograptus perexcavatus* Lapworth, but the thecal measurements differ and the excavations are narrower and not so deep, and are distinctly oblique. Its proximal widening and greater width separate it from *A. confertus*, and the thecal spacing is more lax though the characters of the thecae are very similar. Its greater width and somewhat narrower excavations separate it from the South American *A. cf. confertus* figured by Bulman (1, p. 60, pl. v., figs. 7-9; text-fig. 28).

Horizon and Localities.—Rather common but rarely well-preserved in the upper Darriwilian beds (zone of *Didymograptus nodosus*) of Bendigo East, as, for example, in Sect. XXIX, Huntly.

Family GLOSSOGRAPTIDAE Lapworth, emend. Elles and Wood.

Genus **Glossograptus** Emmons.

The interpretation by Hadding (7, p. 310, fig. 1) of the structure of *Glossograptus* leads to the possibility of two genera being confounded under *Glossograptus*. The question is reviewed by Bulman (1, pp. 68, 69). Our material, unfortunately, is not sufficiently well-preserved to enable us at present to add to the discussion, but as septal spines have not been identified with certainty in *Glossograptus acanthus* E. and W., and are certainly absent in a new form which we have described as (?) *Glossograptus crudus*, the question of the generic characters of *Glossograptus* is left open.

GLOSSOGRAPTUS ACANTHUS Elles and Wood.

(Fig. 3, nos. 13-16.)

1908. *Glossograptus acanthus* E. and W. *Mon. Brit. Graps.*, Part 7, p. 314, pl. 33, figs. 4A-C.

Description.—Rhabdosome sub-fusiform, having a length of 20 mm. or more, widening gradually from the sicular end to a width of 3 mm. or more, and then narrowing distally. Thecae 10 in 10 mm., apertural margins distinctly everted, with robust, rigid, slightly-curved apertural spines, apparently only one per thecae, nearly equal in length to the width of the rhabdosome. No septal spines have been observed. In the proximal region the spines are directed downwards, but they gradually become horizontal and finally have a somewhat upward direction.

Remarks.—The above description differs only slightly from that given by Elles and Wood (*cit. sup.*). A long but thin virgula not noticed in the English description is prominent in many Victorian specimens.

After examination of a great number of forms sufficiently well-preserved to show external characters at least, we have been unable to detect septal or paired apertural spines. This corroborates Elles and Wood's conclusions, and in our opinion it is therefore difficult to retain the present form under *Glossograptus* as at present defined. The heavy spines of the species may be accounted for as being processes formed by the strong development of the apertural mucros, as is seen also in (?) *Glossograptus crudus*, sp. nov.

No evidence of the early stages of the species is available. The absence of a record of scalariform mode of preservation may be accounted for by the width of the rhabdosome being great compared with its thickness, so that it always came to rest in the profile position.

Horizon and Localities.—Common at many upper Darriwilian outcrops in Bendigo East, in the zone of *Diplog. (Glyptog.) intersitus*. Locally it is very abundant as at loc. 196, Strathfieldsaye. Forms referable to the species are also found on a somewhat higher horizon near the old Agricultural Show-grounds at Gisborne, and elsewhere, and on a slightly lower horizon (associated with *D. (Glyptograptus) austrodeniatus*) at Guildford, the Brisbane Ranges, and Lancefield. These lower forms may later be separated as varieties.

(?) *GLOSSOGRAPTUS CRUDUS*, sp. nov.

(Fig. 1, no. 13; Fig. 2, nos. 15-17.)

Description.—Rhabdosome small, rarely more than 10 mm. long, commencing with a width of 2-3 mm., or even sometimes 5 mm., the initial width being usually maintained though some specimens narrow distally. Virgula conspicuous and often projecting beyond the distal end of the rhabdosome, which in juvenile forms is emarginate. Thecae 10-12 in 10 mm., inclined in the distal part at an angle of about 45°, though this angle may be either considerably greater or smaller, about twice as long as wide and with considerable overlap. Apertural margins of these thecae straight or slightly concave and directed upwards, or upwards and outwards. Thecae ending in a stout mucro or denticle directed outwards or slightly downwards.

Remarks.—This previously undescribed graptolite has been known for many years from middle Darriwilian (D4-D3) beds, and is responsible for the reference to *Glossograptus* in these beds. Strictly speaking, it is not possible to include it in that genus as there is no evidence of septal spines even in forms so preserved that, if present, they could hardly escape observation, and the thecae seem to be furnished with a strong mucro instead of the two apertural spines of *Glossograptus*—the apertural walls of the thecae appearing to coalesce ventrally and to be produced into this spinose projection. The species in its juvenile state has a considerable resemblance to *Isograptus* (vide fig. 1, No. 9), and it may form a connecting link between that genus and *Glossograptus*. The species is of importance as being the earliest typically biserial form to develop in the Darriwilian, occurring in the same beds as *Skiagraptus gnomonicus*, but before *Diplograptus* has become established. It shows at times a tendency to split along the median plane, and forms are found with more thecae on one side than the other, indicating either a complete median septum, or possibly that the form has originated by the concrescence of two didymograptid stipes growing back and at an angle of 360°. This would not be surprising if the form is related to *Isograptus*.

Horizon and Localities.—Widely distributed but rarely common in the middle Darriwilian beds along the Barker's Creek-Maldon pipe line (Castlemaine) and elsewhere in the same district; also in beds on the same horizon at Lancefield.

(?) *GLOSSOGRAPTUS CRUDUS*, var. *GISBORNENSIS*, var. nov.

(Fig. 2, nos. 13, 14.)

A form of (?) *Glossograptus crudus* is found rather commonly at some outcrops, e.g., along the Gisborne Creek, which is much narrower than the typical form. This may be separated as var. *gisbornensis*. Its horizon is the same as that of the *forma typica*. The figured specimens are from the Gisborne Creek between the Bullengarook slate quarry and the Gisborne gold mine

Genus *Cryptograptus* Lapworth.

CRYPTOGRAPTUS SCHAFERI (Lapworth).

(Fig. 3, nos. 11, 12.)

1880. *Cryptograptus tricornis* var. *schaferi* Lapworth. *Ann. Mag. Nat. Hist.* (5) v., pl. v., figs. 28A-B.
1908. *Cryptograptus tricornis* var. *schaferi* Lapw. Elles and Wood. *Mon. Brit. Graps.*, part vii., p. 299, pl. xxxii., figs. 13A-C.
1931. *Cryptograptus tricornis* var. *schaferi* Lapw. Bulman, *Arkiv f. Zoologi*, xxii A (3), p. 65, pl. 6, figs. 1-5, pl. 7, fig. 3, text-fig. 31.
1933. *Cryptograptus schaeferi* (Lapworth). Bulman, *Quart. Journ. Geol. Soc.*, lxxxix, p. 352.

Description.—Rhabdosome about 10 mm. long, parallel-sided as a rule, and with a breadth, inclusive of denticles, of about 2 mm., usually with a long virgula sometimes inflated. Thecae 12-10 in 10 mm., with well-marked denticles. The proximal end bears a stout sicular spine, and the proximal thecae have short but well-marked coarse spines. The characteristic long spines of *C. tricornis* are absent. As far as can be made out, the proximal thecae grow downwards.

Remarks.—Lapworth's variety *schaferi* of *C. tricornis* has recently been raised to specific rank by Bulman (2, p. 352), and is so regarded here. Most, if not all, of the upper Darriwilian forms referred to *Cryptograptus tricornis* seem to fall under this heading, including some recorded by Harris (10). Now that the distinction is made future work may show the zonal importance, if any, of the two species.

Horizon and Localities.—Not uncommon in the upper Darriwilian of Bendigo East, most abundant, but sporadic, in the zone of *Didymograptus nodosus*, as at loc. 164, but widely distributed and perhaps ranging as low as the upper part of the D2 (*D. austrodentatus*) zone.

Genus **Lasiograptus** Lapworth.Sub-genus **Hallograptus** Carruthers MS.

LASIOGRAPTUS (HALLOGRAPTUS) PROTEUS, sp. nov

(Fig. 1, nos. 12a-b; Fig. 2, nos. 30-33.)

Description.—Rhabdosome up to 3 cm. in length and 2 mm. wide, exclusive of spines and external meshwork; with the meshwork about 3 mm. Rapidly widening to almost its maximum width in the first two or three mm. and then widening much more gradually to about its centre, after which in mature specimens there is a slight and very gradual narrowing distally. Thecae about 11 in 10 mm., resembling those of *Glossograptus hincksii* (Hopkinson) at first, but later becoming quite distinctive. The spines of proximal thecae are recurved, but those of later thecae become normal to the axis of the rhabdosome, and at last directed distinctly upwards, these distal spines being much more massive than the earlier ones. Network delicate and sometimes only shown on the proximal portion of the rhabdosome, consisting, as usually seen, of an extra-marginal thread independent of the spines and looped to the rhabdosome by supports which alternate with the apertural spines. This apparent independence of apertural spines and meshwork does not seem to be absolute, and is less well shown on the distal portions of rhabdosomes where the meshwork seems sometimes to be supported by outgrowths from the upper side of the spines themselves.

Remarks.—This species is easily distinguished from a characteristic *Lasiograptus etheridgei* Harris by—

- (a) its more parallel-sided and narrower rhabdosome.
- (b) the greater development of spines, giving it a more *Glossograptus* aspect;
- (c) the more regularly developed external meshwork.

A long spine often projects from the proximal end, but its origin and nature cannot well be made out.

Horizons and Localities.—Common at many Upper Darriwilian localities at Bendigo East (zone of *Didymograptus nodosus*). It is probable that MS. records of graptolites from this district include *L. proteus* under *L. etheridgei*. This latter species seems quite distinct and seemingly occurs on a slightly lower horizon. The two species may occur together, but as a rule they do not, there being no record of *L. proteus* from Allot. 95, Woodend; loc. B29, Sect. 20, Newham; nor from loc. A196, Strathfieldsaye, at all of which localities *Lasiograptus etheridgei* occurs, while *Lasiograptus etheridgei* does not seem to be known from such outcrops as loc. 164, Strathfieldsaye. The best specimens of *L. proteus* yet discovered came from this last-named locality and from spoil-heaps between the Eaglehawk and Bendigo Creeks in Sect. XXIX., Huntly.

LASIOGRAPTUS (THYSANOGRAPTUS) ETHERIDGEI Harris.

(Fig. 2, nos. 28, 29.)

1874. *Diplograptus mucronatus* Etheridge. *Ann. Mag. Nat. Hist.* (4), iv., p. 5, pl. iii., figs. 16, 17.
 1924. *Lasiograptus (Thysanograptus) etheridgei* Harris. *Proc. Roy. Soc. Vic.* (n.s.), xxxvi. (2), pp. 98, 99, pl. vii., figs. 3-7.

Remarks.—Two figures of *Lasiograptus (Thysanograptus) etheridgei* Harris are given for comparison with *Lasiograptus (Hallograptus) proteus*, sp. nov. The most obvious differences between the two species are that *L. etheridgei* widens more gradually than *L. proteus* and has a much more fully developed meshwork. The glossograptid thecae of *L. proteus* are also much more clearly seen than the thecae of *L. etheridgei*, and the alternation of meshwork and apertural spines is also more marked in *L. proteus*. Forms, however, occur which can be separated only with difficulty, and it may be that *L. etheridgei*, by modification of thecae and simplification, passes into *L. proteus* and possibly into *Glossograptus hincksii* (Hopkinson).

Horizon and Localities.—One of the commonest graptolites at many outcrops in the upper Darriwilian beds of Bendigo East, as for example at locs. 163, 168, 169, 170, 172, 176, 298, etc., and in Sect. XII., Epsom. It appears on the horizon of *D. (Glyptograptus) austrodentatus* (zone D2), apparently in the higher part of this zone, is very common in some occurrences of the next higher zone (that of *D. (G.) intersitus*), and is commonest in what are probably the lower beds of the zone still higher (that of *Didymograptus nodosus*), then giving place in still higher beds to *Lasiograptus proteus*, with which, however, it may occur sparingly as at loc. 298. Outside the Bendigo district it occurs near Allot. 95, Woodend, and at Cobaw, as well as other less well-known outcrops.

Family ISOGRAPTIDAE Harris.

Genus **Cardiograptus** Harris and Keble.

CARDIOGRAPTUS CRAWFORDI Harris.

(Fig. 2, no. 26.)

1926. W. J. Harris. *Proc. Roy. Soc. Vic.* (n.s.), xxxviii, p. 57, pl. i., figs. 5-7.

In the original description of *C. crawfordi* (Harris, 1926, p. 57) it was stated that *C. crawfordi* could be distinguished from *C. morsus* H. and K. by smaller size and less pronounced emargination. Since then forms have been discovered which are undoubtedly *C. crawfordi*, but which also show distinct distal emargination. One of these is figured. The locality is north-west of Strathfieldsaye township (loc. 196) and the horizon is the lower part of the D1 (zone of *D. (Glyptograptus) intersitus*). Similar emarginate forms are also found on the higher horizon (zone of *Didymograptus nodosus*) of Sect. XXIX., Huntly.

List of Localities.

Localities mentioned by numbers or letters in this article are as follows:—

- A 164. Emu Creek Water Race, No. 2, at the S.E. corner of allot. 19, sect. III., Parish of Strathfieldsaye.
- A 169a. On E. and W. road near S.E. corner of allot. 25, sect. III., Parish of Strathfieldsaye.
- A 170. On E. and W. road near S.E. corner of allot. 27, sect. III., Parish of Strathfieldsaye. (Outcrop hardly exposed.)
- A 173. On Emu Creek No. 2 Water Race, near N.E. corner of allot. 1A of sect. V., Parish of Strathfieldsaye.
- A 176. On Strathfieldsaye-Sedgwick road, about 11 chains N.W. of S.W. corner of allot. 1B, sect. V., Parish of Strathfieldsaye. (In small gutter on S.W. side of road.)
- A 196. Near the most northerly corner of allot. 3, sect. XIX., Parish of Strathfieldsaye. (An extensive surfaced area.)
- A 198. On S. side of E. and W. road, N. of allot. 8, sect. VI., Parish of Strathfieldsaye. (On slope above the right bank of Axe Creek.)
- A 210. In bed of small watercourse on S. side of Bendigo-Heathcote road, about 170 yards W. of 97-miles 36-chain crossing on Bendigo-Heathcote railway, Parish of Strathfieldsaye.
- A 298. In bed of watercourse in allot. 2, sect. V., Parish of Sedgwick.
- A 310. In bed of eastern tributary of watercourse in allot. 2, sect. XI. Parish of Sedgwick.
- CH 6. Chinamen's Creek, near Muckleford railway station. (Note 6, Q.S. 15 N.W.)
- S.F. Sewerage Farm, allot. 8, sect. XXIX., Parish of Huntly.
- G.C. Near N.E. corner of allot. 58, Parish of Bullengarook (cliff on south bank of Gisborne Creek).
- Ba67. Near junction of Riddell and Gisborne Creeks (Q.S. 6 S.E.).

NOTE.—“A” numbers are from the plans of J. J. Caldwell, Geol. Survey of Vict. Other numbers refer to specimens in the Geological Survey Museum.

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FIGURE 1.

All Figures are $\times 3\frac{1}{2}$ except where otherwise stated.

- No. 1. *Pterograptus incertus*, sp. nov. (a) proximal portion (30795), (b) proximal portion of stipe (30795). Loc.
- No. 2. *Trichograptus immotus*, sp. nov. (a) proximal portion (37434), (b) proximal portion (37442), (c) distal portion (37434). Loc. S.F.
- No. 3. *Didymograptus distinctus*, sp. nov. (37431). Fryerstown water-race, south of Elphinstone railway tunnel.
- No. 4. *Didymograptus cognatus*, sp. nov. (a) proximal portion (37401 b), (b) distal thecae (37401 a), (c) proximal portion (37418) $\times 10$. Loc. A 164.
- No. 5. *Didymograptus dubitatus*, sp. nov. (a) proximal portion (37404), (b) distal thecae (37404), (c) proximal portion (37404) $\times 10$, (d) distal thecae (37404) $\times 10$. Loc. A 164.
- No. 6. *Didymograptus compressus*, sp. nov. (a) proximal portion (37405), Loc. A 196, (b) distal fragment, (37405) Loc. A196, (c) distal thecae, (37417, b) $\times 10$. Loc. A. 173.
- No. 7. *Didymograptus nodosus* Harris. (37448.) Loc. A 164.
- No. 8. *Didymograptus compressus* mut. (a) proximal portion, (37440), (b) distal thecae (37440). Loc. A 173.
- No. 9. *Didymograptus cuspidatus* Ruedemann, (37402). Loc. A 164.
- No. 10. *Diplograptus (Amplexograptus) modicellus*, sp. nov. a, b, c, d, to show various growth stages. (37394, 10c is 37444) (e) to show long virgula (37393), (f) Type (37392). Loc. A 164.

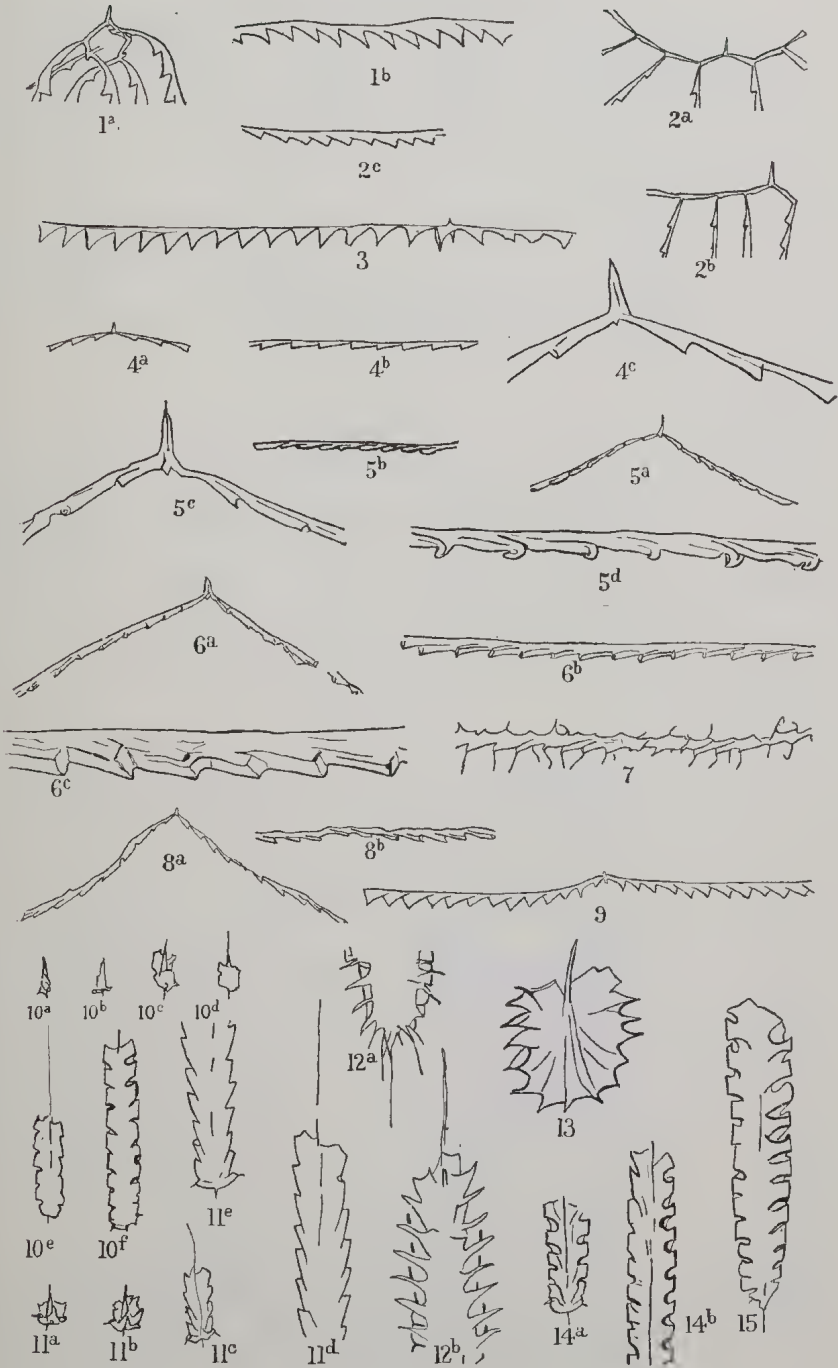


FIG. 1.

- No. 11. *Diplograptus (Glyptograptus) intersitus*, sp. nov. (*a*, *b*, *c*) young forms $\times 4$ (37377). Loc. A 298. (*d*) distal $\times 4$ (37428*a*), Loc. A 196, (*e*) proximal portion, (37428 *b*,—counterpart of 37428 *a*). Loc. A 196.
- No. 12. *Lasiograptus proteus*, sp. nov. (*a*) proximal portion (37422), (*b*) distal portion (37421). Loc. A 164.
- No. 13. (?) *Glossograptus crudus*, sp. nov. Young form $\times 4$ (37409). Loc. A 164.
- No. 14. *Diplograptus (Amplexograptus) confertus* Lapw. (*a*) proximal portion $\times 4$ (37414), (*b*) distal portion $\times 4$ (37414). Loc. S.F.
- No. 15. *Diplograptus (Amplexograptus) differtus*, sp. nov., $\times 4$ 37385 *a*—counterpart of Type 37385). Loc. S.F.

FIGURE 2.

Figures are natural size unless otherwise stated.

- Nos. 1-6. *Pterograptus incertus*, sp. nov. 1, 2. (30795). Loc. A 170, 3. Type. (37433). Loc. A. 170. 4. (37438). Loc. A. 210. 5. (opposite side of 4, on same slab) (37438). Loc. A 210. 6. (reverse of 30793). Loc. A. 170.
- Nos. 7-9. *Trichograptus immotus*, sp. nov. 7. (37442). Loc. S.F. 8. Type (37434). Loc. S.F. 9. Type (37400). Loc. A 160.
- No. 10. *Didymograptus distinctus*, sp. nov. (37431) (*vide* Fig. 1, No. 3).
- Nos. 11, 12. *Didymograptus cuspidatus*, Rued., (37402, 37403). Loc. A 164.
- Nos. 13, 14. *Didymograptus cognatus*, sp. nov., type, (37401, 37425). Loc. A 164.
- Nos. 15-17. (?) *Glossograptus crudus*, sp. nov. (37406, 37408, 37415). Loc. CH 6.
- Nos. 18, 19. (?) *Glossograptus crudus*, var. *gisbornensis*, var. nov. (37407, 37407 *a*). Loc. Gisborne Creek. (G.C.)
- Nos. 20, 21. *Didymograptus compressus*, sp. nov. 20. Type, (37405). Loc. A 196. 21. Corrugated dorsal margin indicating approximation to nodose form *D. nodosus* (37417). Loc. A 173.
- Nos. 22-25. *Didymograptus dubitalus*, sp. nov., Loc. A 164. 22. Type, (37404). 23. (37416). 24. Proximal portion of young form on same slab as 23 ($\times 2\frac{1}{2}$). 25. Type, distal portion of stipe of type specimen (37404).
- No. 26. *Cardiograptus crawfordi* Harris, shows emarginate rhabdosome not a specific character of this form (37410). Loc. A 196.
- No. 27. *Didymograptus nodosus* Harris, shows spines at apertures and dorsal nodes of thecae (37445). Loc. S.F.
- Nos. 28, 29. *Lasiograptus etheridgei* Harris (37435, 37436). Loc. A 176.
- Nos. 30-33. *Lasiograptus proteus*, sp. nov. 30. Type (37432). Loc. S.F. 31. With long proximal spines and virgula (37421). Loc. A 164. 32. Young form showing well preserved meshwork (37423). Loc. A 164. 33. Typical young rhabdosome (37424). Loc. A 164.

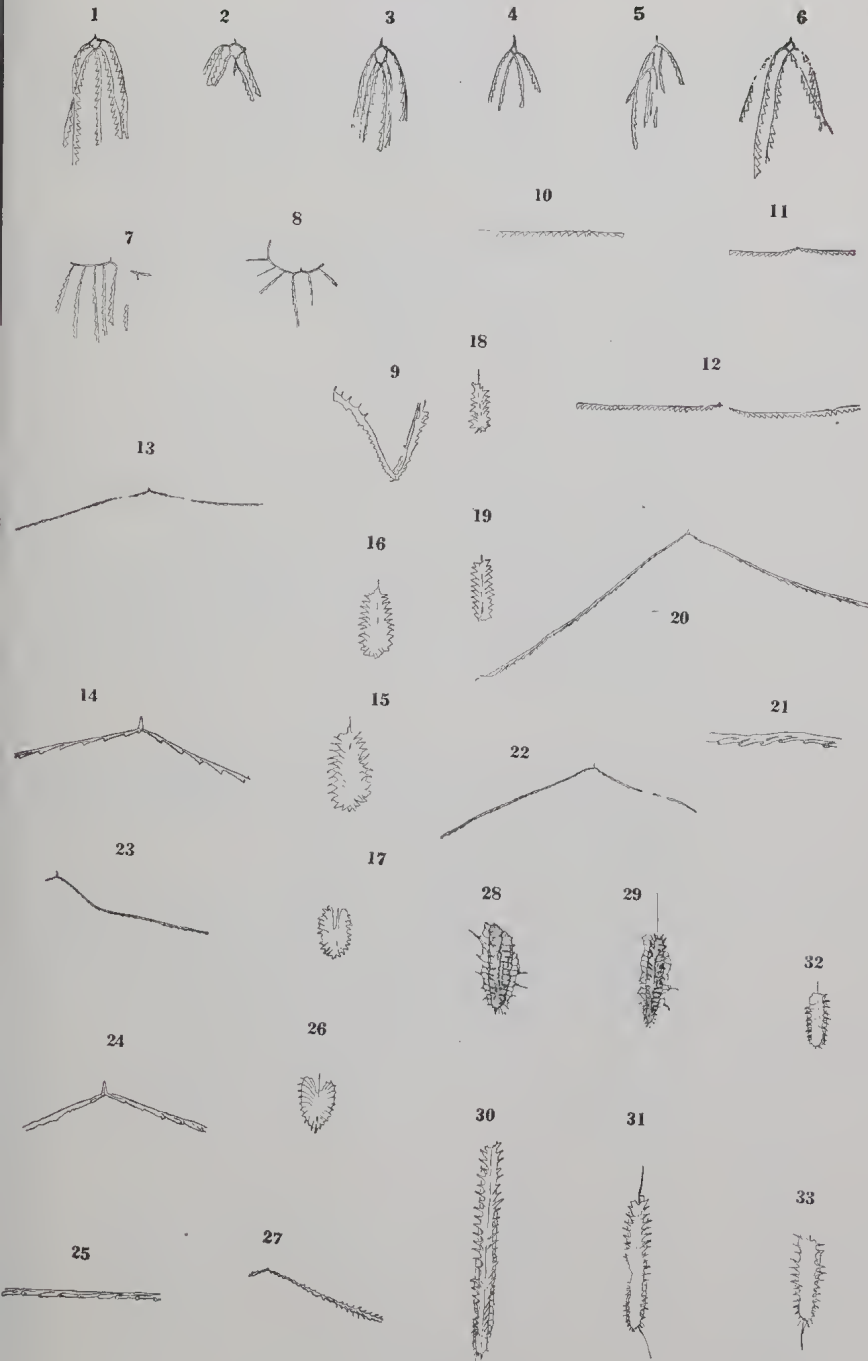


FIG. 2.

FIGURE 3.

Figures are natural size unless otherwise stated.

- Nos. 1-5. *Diplograptus* (*Glyptograptus*) *austrodentatus* (Harris and Keble). 1. Small form from D2 horizon (low.), (37372). Loc. A 198. 2. Typical rhabdosome (37373). Loc. A 310. 3. Typical rhabdosome (37374). Loc. A 310. 4. Typical rhabdosome (37375.) Loc. A 310. 5. Typical rhabdosome (37376). Loc. A 310.
- Nos. 6-10. *Diplograptus* (*Glyptograptus*) *intersitus*, sp. nov., 6. Type *b*, (37428). Loc. A 196. 7. Distal counterpart of type (37428). Loc. A 196. 8. Marked 8 on slab, (37427). Loc. A 196. 9. Marked 9 on slab, (37427). Loc. A 196. 10. Smaller rhabdosome, (37377). Loc. A 298.
- Nos. 11, 12. *Cryptograptus schaeferi* Lapworth. 11. A typical group (37384). Loc. S.F. 12. (37439). Loc. A 164.
- Nos. 13-16. *Glossograptus acanthus* E. and W. (37412, 37430, 37413, 37411). Loc. A 196.
- Nos. 17-20. *Diplograptus* (*Amplexograptus*) *modicellus*, sp. nov., 17. Type (37392). 18. (37393). 19. Shows virgula and virgella (on same slab as 18). 20. (37395). Loc. A, 164.
- Nos. 21-26. *Diplograptus* (*Amplexograptus*) *confertus* Lapworth. 21. Reverse aspect of long rhabdosome, (37388). Loc. S.F. 22. Obverse aspect of shorter rhabdosome (37384). Loc. S.F. 23. Reverse aspect (37443). Loc. S.F. 24. Obverse aspect and shorter rhabdosome (37391). Loc. S.F. 25. Obverse aspect and shorter rhabdosome (37390). Loc. S.F. 26. (37429). Loc. S.F.
- Nos. 27-31. *Diplograptus* (*Amplexograptus*) *differtus*, sp. nov. 27. Obverse aspect, (37384). Loc. S.F. 28. Type, obverse aspect, (37385). Loc. S.F. 29. Obverse aspect, (37386). Loc. S.F. 30. Distal portion showing characteristic Amplexograptid thecae, (37387). Loc. S.F. 31. Intermediate aspect, (37384). Loc. S.F.
- Nos. 32-38. *Diplograptus* (? *Mesograptus*) *decoratus*, sp. nov. 32. (37446). Loc. T.Q.M. 33. (37381). Loc. B.29. 34. (37379). Loc. A 176. 35. Type (37378), Limonite pseudomorph in relief. Loc. B/HR. 35A. Medial portion of Type $\times 2\frac{1}{2}$. 35B. Cross section of distal portion of Type $\times 2\frac{1}{2}$. 35C. Lateral view of distal thecae of Type $\times 2\frac{1}{2}$. 36. (37380). Loc. S.F. 37. (37382). Loc. S.F. 38. (37384). Loc. S.F.
- Nos. 39-41. *Diplograptus* (*Glyptograptus*) *cuglyphus* Lapworth. 39. (37396). Loc. T.Q.M. 40. (37397). Loc. Ba67. 41. (37398). Loc. T.Q.M.

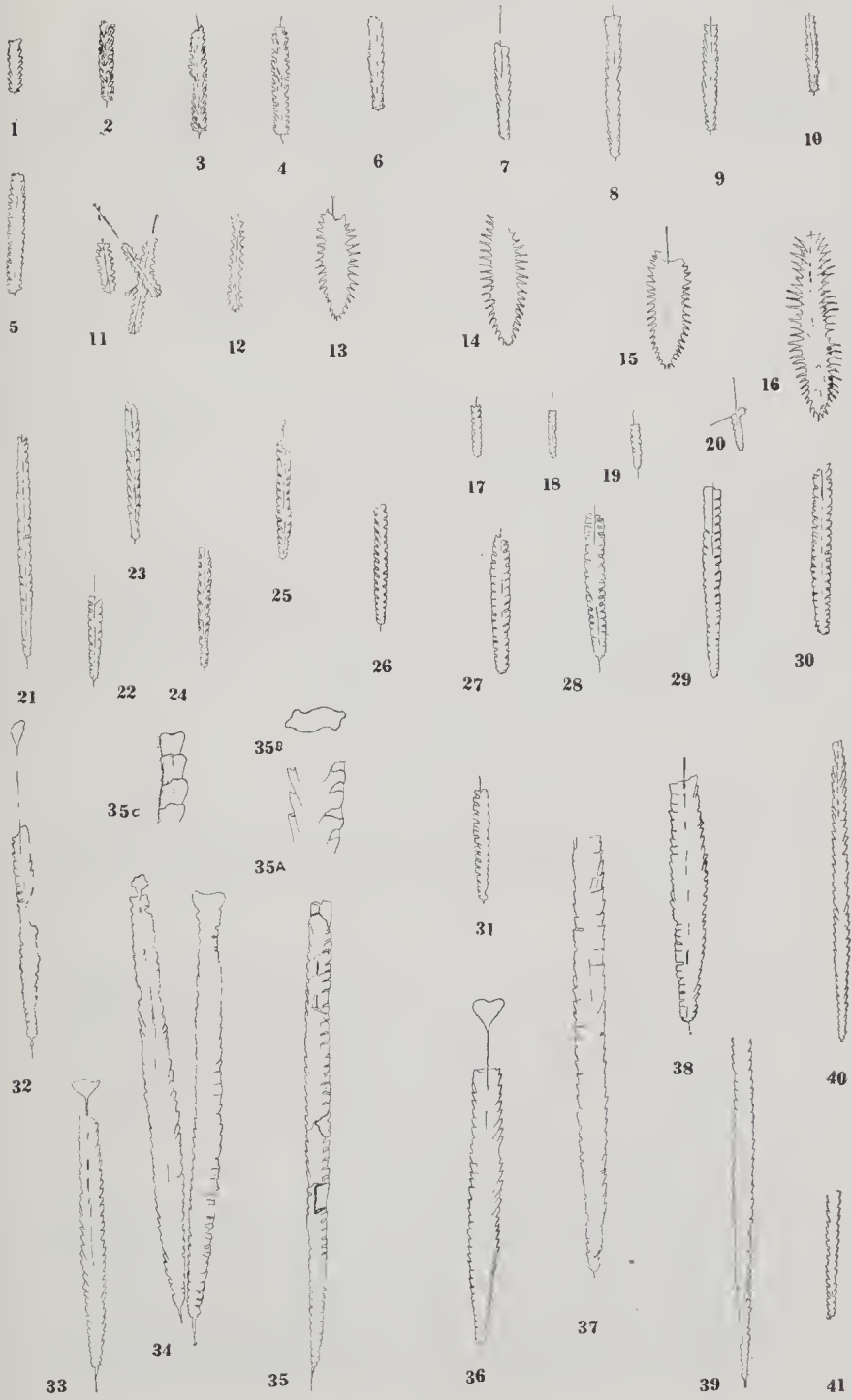


FIG. 3.